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ABSTRACT

This paper describes a project which created a set of World Wide Web (WWW) pages documenting the state of the art in educational multimedia design; a prototype WWW-based multimedia teaching tool--a podiatry test using HTML forms, 24-bit color images and MPEG video--was also designed, developed, and evaluated. The project was conducted between sites in the United Kingdom and Australia, using the WWW and other Internet functionality to exchange and share information, giving valuable first-hand experience of the benefits and frustrations of online cooperation. Topics discussed include new Internet functionality; the WWW for research and information seeking; the WWW as teaching tool; the WWW as examiner; the WWW as an educational forum; the WWW in collaborative education; the multimedia based-teaching and assessment tool; and a case study in distance learning and supervision. (Author/DLS)

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The Impact on Education of the World Wide Web

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The Impact on Education of the World Wide Web

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Abstract: Although interest in the WWW as a way to teach and to empower students is increasing, on-line classrooms are still few and far between. The newer Internet technologies may help change this. For example, developers are now experimenting with technologies which can provide users with synchronous communication, using video cameras to allow easy access to live discussions in a WWW environment.

This paper describes a project which created a set of WWW pages documenting the state of the art in educational multimedia design, and then went on to design, develop and evaluate a prototype WWW-based multimedia teaching tool - a Podiatry test using HTML forms, 24-bit colour images and MPEG video. The project was conducted between sites in the UK and Australia using the WWW and other Internet functionality to exchange and share information, giving valuable first-hand experience of the benefits and frustrations of on-line cooperative working.

New Internet Functionality

The WWW has found enormous success through word of mouth coupled with the enthusiastic support of the media. Probably more importantly, commercial developers have now adopted the WWW as a new advertising medium. Along with this increase in popularity, there has been a rush to incorporate new features into the software, many of which can facilitate and enhance specific educational modes discussed later in this paper. For example, as HTML has evolved, new features have been added such as interactive forms, defined "hot spots" in images, more versatile layout styles, and formatted tables. An interesting area is the integration of new Internet technologies into the WWW. For instance, Internet Relay Chats (real-time group discussions) and MUD's (Multiple User Dungeons, essentially an IRC in an interesting setting) provide users and designers with the ability to interact with each other live instead of, for example, having to wait for a mailing list to distribute the information as it is posted via e-mail. Another Internet technology being integrated into the WWW is CUSeeMe sites (ftp://gated.cornell.edu/pub/video). CUSeeMe is a teleconferencing program which allows users to see and hear each other by converting the data from a video camera into an Internet compatible format. Functionality such as this combined with the WWW's built-in audio-visual capabilities suggests new possibilities for group-based on-line education.

Another influence likely to affect the WWW in a major way is HotJava, a WWW browser developed by Sun Microsystems (http://java..sun..com/) that can execute programs (known as applets) written in the Java programming language and included (like images) in HTML pages. The Java language is the first to present a comprehensive solution to the challenges of programming for the Internet, providing an object-oriented programming language optimised for the creation of distributed, executable applications and offering portability, security, advanced networking and reliability without compromising performance. Because Java is compiled into machine independent bytecodes, applications written in Java can migrate transparently over the Internet, accessible by anyone using the HotJava browser or any other Java enabled browser. Netscape Navigator, by far the most popular WWW browser, now offers Java support enabling it to download Java applets to run on a wide variety of client systems. Java has been available since April 1995 for developers using the Sun Solaris or SunOS platforms. More recently the availability of the language has been extended to other varieties of UNIX, Microsoft's Windows NT and Windows 95 operating systems.

The RealAudio (http://www.realaudio.com/) player is a another good example of how the WWW technology is being advanced. It gives WWW users equipped with only a standard multimedia personal computer and a 14.4 Kbps modem instantaneous access to real-time audio programming. It uses highly compressed audio files which, rather than being downloaded and then played as a complete file, are received incrementally with each segment fed to the RealAudio player as it arrives thus enabling continuous play from the outset. This technology makes audio-on-demand as practical as delivery of text and graphics, overcoming the significant downloading delays that have hitherto presented an obstacle to its informational, recreational and creative use.

The latest extension of the WWW browser is the development of "plug-ins". These application are written by third parties and extend the functionality of the browser offering features such as video and audio compression and decoding, virtual reality markup language (VRML) support and video/audio conferencing within the browser's Graphical User Interface.

The WWW for Research and Information Seeking

The WWW has grown from its origins as a simple system for distributing documents and communicating among members of the high-energy physics community into a more general multimedia tool of wider appeal. Nevertheless, its use as a research tool continues and has increased enormously. Research institutions and universities have established home pages and the WWW is increasingly used to advertise the work and interests of departments and staff. Researchers are still some of the keenest users of the WWW in view of its potential for contact and collaboration, for disseminating research findings, and for facilitating peer review of the outcomes of research [Russell & Baird 1995].

Despite the magnitude of the information available, using the Web is a simple matter, even for young children, so that anyone with the desire and the time to explore is bound to discover a variety of fascinating sites and resources. Yet because of the vast numbers of WWW sites, knowing where to begin searching, what to look for, and what to ignore can be a daunting task. The development of what are known as webworms, spiders, and knowbots (computerised search agents which will scan the Internet looking for requested information) has facilitated searches somewhat although it has brought another problem in that an overwhelming amount of reference material may be returned. This has been helped somewhat by individual WWW users who have already begun to catalogue the enormous variety of educational resources available on-line. As this information is compiled, it becomes available to the educational community in the form of on-line resource guides, some of which are no more than hypertext lists of known educational resources.

The educational resources page designed and constructed as part of this project is an example of this kind of listing. A set of WWW pages (http://www.dstc.edu.au/AU/staff/richard-taylor/education/) was developed to offer the reader a practical means of following up the educational resources discussed. The pages were designed and constructed featuring sites demonstrating interesting and innovative educational pages and existing on-line courses which were considered to exploit some of the best educational features of the WWW. As designers of WWW sites develop more on-line resource guides, the WWW will begin to resemble a World Wide Library Catalogue although, unlike a traditional library, the books and other documents that are available will have been created by students, lecturers and anyone else with an interest in contributing. In consequence, as the WWW grows, so will easy access to useful and interesting information. There are naturally concerns over the reliability of the knowledge that is being published on the WWW. [Treloar 1995] suggests, however, that there is no reason why Web-published journals should not be subject to the same peer review processes that apply in the print world.

The WWW as Teaching Tool

From a curricular point of view, the WWW can be used to design tutorials and on-line lessons for a variety of subjects. For example, [Blumberg 1994] describes an on-line teaching tool for basic genetics known as MendelWeb (http://netspace.org/MendelWeb/) that integrates elementary biology, discrete

mathematics, and the history of science. MendelWeb is constructed from Gregor Mendel's 1865 paper *Experiments in Plant Hybridisation* presented as an active document, with links to traditional reference material (e.g. glossaries, biographies, and the original German text) as well as images, tutorials, active commentaries, related Web sites, and animations. Discussion and questions are presented as they would be in a live introduction to biology course - students may choose in what order they wish to explore the topics, enabling them to develop their comprehension of the subject at their own rate.

The authors of such systems have usually carefully mapped out the possible outcomes of each piece of information offered. A successful WWW system such as MendelWeb will therefore be crafted with sometimes thousands of links and hundreds of pages. The proliferation of automatic HTML authoring programs suggests that creating such linkages in the future will no longer seem a daunting task. Furthermore, hyperbook design may become even further simplified as a result of work by programmers at Brown University who are working on what are known as ASK systems - automatic, intelligent computer programs which will analyse a document's content with inquisitive search agents in order to help formulate questions that might be raised by that content. The WWW is therefore beginning to provide the necessary tools with which to design on-line teaching material. However the potential of WWW teaching packages has yet to be realised largely because most WWW books have been technically oriented. In order for this technology to reach the mainstream subject areas, WWW tutorials must be designed for less technical subjects like history, music, language, arts. For example, a site specialising in the complete works of Shakespeare site could include question and answer sessions, as well as audio and video clips of each play and poem. Using appropriate tools, the capability to transform a topic of choice into a document that could be useful and educational for students could be available to everyone.

The WWW as Examiner

The developments in HTML that have introduced the ability of the WWW to display fill-in forms can also help create interactive educational pages. Educational sites have begun offering tests and quizzes for both assessment and self-assessment. The Podiatry test developed during this project and described in more detail below is an example of this kind of application of the WWW. However, it is not yet generally productive to produce this kind of interactive software on the WWW. For example, in the area of medicine which is very visually intense and information rich [Cho 1994], it is not easy for specialists with little training in computer science to write scripts that create and manage forms and interact with other software on the server. Another technical problem discussed by [Ibrahim & Franklin 1995] in relation to these kinds of interactive applications is the fact that the http protocol is stateless in the sense that there is no direct relationship between two consecutive requests to the same server, even if the queries come from the same user. The server treats every request it receives independently from any other request it received in the past or that it will receive in the future. From a technical perspective, this statelessness allows the http server software to impose very little overhead on the server machine, and keeps the protocol between the client and server very simple. Nevertheless, from a learning point of view the statelessness of the http protocol (meaning that the connection to a server is closed after a requested document is delivered) is a serious shortcoming preventing intelligent interaction.

The WWW as an Educational Forum

Proponents of the Internet have long promoted its use as a forum for discussion and as a marketplace for ideas and information. The WWW also fulfils this goal, and in terms of use in the education community, the WWW can provide a basis for virtual debate and discovery. All of the original uses of the Internet - including file transfer protocol (ftp), e-mail, USENET news, and gopher continue to thrive in the context of the WWW and have now converged into a singular informational tool, since the latest generation of WWW browsers, such as Netscape Navigator are capable of interacting with the full suite of Internet protocols. Because of this, it is conceivable for a designer to utilise all of these services to set up a multimedia/hypermedia discussion on any given subject. As a basis for such discussions, Internet users have traditionally used mailing lists to form a discussion group, receiving information from and posting information to the mailing list via e-mail which in turn then distributes the information to everyone on the list. Recently, some organisations have even used mailing lists to run virtual conferences, where

sometimes thousands of people sign up to an on-line discussion and take part in a week-long forum, all without leaving their homes or offices.

For educators, this combination of presentation (the WWW) and critique (mailing lists) can be used successfully in a variety of ways. For instance, a teacher could set up a WWW site which comprises the lectures, frequently asked questions, and multimedia presentations. Via a mailing list, students could automatically add information to that site in the form of additional questions, reports, essays, etc. In this case, they could use mail-to-HTML converters and so would not need to become experts in HTML. The software would then automatically append their message onto the page itself, so future site visitors will be able to read the comments. The educational potential of such a system cannot be ignored although the uncontrolled and unrefereed nature of the material again has to be born in mind.

Students can also use the various Internet technologies to create their own hypertext work and then present it on-line so that their peers and lecturers may discuss and review it. Learning how to critique others' work and to present a persuasive, constructive argument are skills that are often gained slowly for many students, for they are rarely taught in any formal fashion [Laurillard 1995]. Further, on-line electronic discussions apparently seem to be less threatening for some than standing up in front of peers. In addition, because conversation is electronic, it can be automatically catalogued and presented by the student as part of the project. This is not to propose that traditional class presentations should vanish with the advent of on-line class forums, but that allowing students to work with and learn from each other in such a way could encourage the many students who previously did not easily contribute voluntarily to a discussion.

The WWW in Collaborative Education

In its present form the WWW is not very well suited for collaborative work which requires a high degree of real-time interaction. Prototypes for synchronous communication such as Web-Chat exist but are currently unstable and slow. One of the most exciting recent developments for collaborative education are WWW interfaces to Multi-User Dungeons (MUD's) and Object-oriented MUD's (MOO's). [Curtis & Nichols 1993] describe a MOO as a network-accessible, multi-user, programmable, interactive system well-suited to the construction of text-based adventure games, conferencing systems, and other collaborative software. Its most common use, however, is as a multi-participant, low-bandwidth virtual reality. Participants give one-line commands that are parsed and interpreted as appropriate. Such commands may cause changes in the virtual reality, such as the location of a character, or may simply report on the current state of that reality, such as the appearance of some object. The database contains representations of all of the objects in the virtual reality, including the MOO programs that the server executes to give those objects their specific behaviours.

MOO's allow for individual users to extend the environment by "building" or creating new objects. In an educational context this can allow the student to become an active participant in the learning experience. In addition, it is well documented in the literature that MOO's provide a strong sense of "place", possibly bringing back some of the social intercourse of "campus" life that is lost in distance education. A MOO server can also be configured to act as an http server. This means that a WWW browser can be used to look at locations, rooms, people, artefacts, etc. in the MOO. These objects can have hypertext URL's attached and therefore be used to structure information on the WWW. An example use of a MOO in an advanced educational setting is the Global Network Academy (GNA) 'Introduction to Object Orientated Programming using C++' course (http://info.desy.de/pub/uu-gna/html/cc/index.html). The long term goal of the GNA is to become a fully accredited on-line university. The course was built around four main components, a hyperbook, mailing lists, practical projects and MOO interactions [Perron 1994].

A Demonstration of the Educational Potential of the WWW - The Multimedia Based Teaching and Assessment Tool

The process of exploring the WWW is in itself a educational experience. There are however more structured ways that the WWW can be used in the educational context. With the continuing development of HTML and its ability to use display fill-in forms, courseware designers are now able to create

educational material that has most of the characteristics of courseware built on stand-alone machines. To explore this capability further a WWW-based Podiatry test was developed and evaluated.

In consultation with a lecturer in the Podiatry School at Queensland University of Technology a Multimedia Podiatry Test (http://www.dstc.edu.au/AU/staff/richard-taylor/podiatry/Podtest.html) was constructed on its home page. The questions for the test were taken from existing paper-based questions. Once completed, the test was demonstrated to a lecturer at the Podiatry School, and then to a practising podiatrist. The feedback from both parties was very encouraging. The lecturer considered that the functionality of the test would be a useful addition to the pedagogical tools available to him; the practising podiatrist was interested in the prospect of having available an on-line multimedia test incorporating high quality colour images and video since practising podiatrists in Australia are often spread over very large areas at considerable distance from a Podiatry School.

A Demonstration of the Educational Potential of the WWW - A Case Study in Distance Learning and Supervision

One obvious role for the WWW, using all of the above scenarios is in Distance Education [Ibrahim 1994]. The United Kingdom's main distance educator, its largest University and also its largest publisher, namely the Open University (http://www.open.ac.uk), is now beginning to exploit the WWW. Compared to a traditional distance education system of paper and post, some of the benefits of the WWW for dissemination of material include the ability of the training centres to distribute the knowledge on a large scale almost instantaneously; the reduction of mailing costs which allows distribution of pages without the overhead associated to printing costs and transport, the correction and updating of all information for all users from just one server site, the availability of a variety of different teaching styles and modes of communication between teachers and learners, facilitation of collaborative writing between authors, and improved mechanisms for students to give and receive feedback more easily.

The above Podiatry project itself was an exercise in distance education, as the research and practical work were completed in Australia with the supervisor based in the United Kingdom. All supervision of the project was performed over the Internet, with the majority of the communication using e-mail. 'Interactive' progress meetings were conducted using the simple text based TALK program, accomplished by connecting to an Internet server at a mutually convenient time pre-arranged by e-mail. When it worked well, this facility was invaluable. However, on numerous occasions the server and Internet connection suffered severe performance problems. This manifested itself by either hanging the program or slowing it down to such an extent that it ceased to be interactive and had to be abandoned at that time. Real-time meetings were also conducted using Internet Relay Chat (IRC). This helped alleviate the performance bottleneck and also provided a slightly more user friendly graphical user interface. The practical components of the project and the draft and final project reports were exchanged by e-mailing the URL address of the relevant work, and using a portable document format for the transfer.

On the one hand there was some frustration in getting the tools and services to work and with the poor quality of some of the services, but on the other hand the use of email for the bulk of the conversation exchange proved quite adequate, especially when it could be supplemented with IRC. Internet Phone took this one step nearer to face-to-face contact by allowing interactive audio. In addition, the use of the WWW enabled immediate viewing of the constructed web-pages of educational sites and of the Podiatry test demonstration. Whilst the setting up and use of these communication systems created an additional time overhead in the project that would not have been a factor in the traditional case, without them supervision of the project would not have been not have been practicable within the available time scale.

Conclusions

Assuming that the future of the WWW is secure, at least for the foreseeable future, it is inevitable that education will stand to benefit as a result of the continuing growth and development of this

information-rich environment. The most significant impact is likely to come in the distance education arena where the remote use of advanced teaching materials will reduce costs and enable more students to gain a useful education. The WWW's potential collaborative features will, as they evolve further, offer greater interaction between distance education students.

The practical components of this project demonstrated the large quantity and varying quality of educational material already available on WWW. At this relatively early stage of development of the WWW it is not surprising that a proportion of the published material is not of high quality. However, it is encouraging that many of the visited educational WWW sites were useful and informative. The cataloguing of the enormous variety of educational resources available on-line, and the publishing of these lists is a useful and important activity. The continuing compilation of related WWW sites will increase the usability of the WWW in all areas, including education.

The WWW seems particularly well suited to education in a medical area such as Podiatry which is visually intensive. The WWW's inherent multimedia capabilities are well used in such an application, suggesting that its adoption for this kind of teaching environment is a real possibility. The use of the WWW and the Internet for the supervision of this project offered some valuable insights into the problems that may be encountered in the development of WWW-based education. Despite the initial time overheads, it is likely that the increase in demand for distance learning which has already begun may well be satisfied, at least in part, by the types of the WWW functionality discussed in this paper. Furthermore, the lack of face-to-face communication may be ameliorated in the future by the introduction of affordable, Internet-based, video-conferencing systems.

Above all, institutional access to the Internet and the WWW in particular must increase dramatically. Governments must propose and support schemes such as the UK Labour Party's promise (http://www.poptel.org.uk/Labour-Party/execsumm.html) to ensure a WWW facility in every school. Universities must realise the potential of the technology and invest in the infrastructure to offer WWW facilities to every faculty, again with the required support, and a recognition that the WWW can have a major impact on undergraduate and graduate education. Further development of the cable and telephone infrastructure, and the lowering of call charges will increase the availability of access still further, and as more participants contribute to the WWW the more useful it will become.

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